

Some data are given from the early results of the Harvard Seismograph Station's program of recording dynamite blasts, which give travel-times for *P* and *S* for use in computing local earthquake distances. A low ratio of felt to recorded earthquakes, and the urgent need for more Benioff installations in the area, are cited.

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\*\* Seismologist in Charge.

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### *EQUATORIAL LONGITUDE EFFECTS ON COSMIC RAYS*

BY ROBERT A. MILLIKAN AND H. VICTOR NEHER

NORMAN BRIDGE LABORATORY OF PHYSICS, CALIFORNIA INSTITUTE OF TECHNOLOGY

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At the meeting of the National Academy just a year ago Dr. Neher and I presented our evidence for a previously unsuspected effect in cosmic rays which we termed the "longitude effect." This effect had been brought to light by the sending of vibration-free self-recording electroscopes on a number of voyages from Los Angeles to Mollendo, Peru, and back, and at the same time on a Dollar Line trip around the world. The very accurate records obtained on these voyages, when studied carefully in the laboratory in January 1934, brought to light the fact that in going from the north temperate zone into the equatorial belt the decrease in the sea level cosmic ray intensity is only 8 per cent between San Francisco and Mollendo while it is 12 per cent when the passage from the temperate zone into the equatorial belt takes place on the other side of the world, that is, in the region of Singapore and Batavia. Several months later we learned that Professor J. Clay, of Amsterdam, had observed a similar qualitative difference in two voyages which he made at essentially the same time as those made by us, one of his voyages taking him between Amsterdam and Batavia around the Cape of Good Hope and the other through the Suez Canal. Professor Clay published a paper in the March number of the Dutch magazine *Physica*, in which he referred very briefly to these results, so that priority in the publication of the discovery of the longitude effect belongs to Professor Clay. The agreement however in the results found simultaneously and independently in different parts of the earth by different observers puts beyond doubt the reality of the effect.

The importance of the effect is obvious when it is reflected that the charged particles which alone can be responsible for this longitude effect must have gained their deflections in the earth's magnetic field at dis-

tances thousands of miles above the earth's surface, so that the existence of the effect means that, contrary to the well-known gaussian assumption, the earth's magnetic field even at distances thousands of miles out in space is essentially dissymmetrical with respect to any line passing through the center of the earth. The longitude effect in cosmic rays provides then the first means of making a survey of the extent and nature of that dissymmetry. All the sea level surveys of the earth's magnetic field which have been made in such numbers during the past three hundred years and which have had such utility for the navigator have been limited to the measurement of variations in the components of the magnetic field at *the surface of the earth*.

In view of the significance of such a survey, Dr. Neher and I have gone intensively at the problem of getting accurate data as fast as possible on the sea level cosmic ray intensities. We have sent one shielded electro-scope from Los Angeles to Sydney on the Matson Line, and also an unshielded electro-scope over the same route. We have sent another electro-scope to Peru, which was placed by our collaborator, Dr. Korff, on a freighter which made the trip from Mollendo through the Canal to Liverpool and then from Liverpool back around South America through the Straits of Magellan, and then up the west coast of South America to Valparaiso and Mollendo. We have also sent a second electro-scope on a Dollar Line trip around the world. In addition we now have other instruments which are traversing the Southern Hemisphere on the Franconia of the Cunard Line.

The results of all the voyages thus far completed are in agreement with the general conclusions announced a year ago, namely, that the dip in the cosmic ray intensities in crossing the equatorial belt along the west coast of South America is 8 per cent; that in crossing this belt farther west in the Pacific in the route from Los Angeles to Sydney this equatorial dip is 10 per cent; in crossing in the neighborhood of Singapore and Batavia it is 12 per cent; in crossing through the Atlantic from Liverpool to the Straits of Magellan it is  $8\frac{1}{2}$  per cent. Within the limits of our experimental uncertainty which does not exceed one per cent, these figures are the same whether we use electroscopes shielded with ten centimeters of lead or whether we use unshielded electroscopes.

Another important result is that in the neighborhood of Los Angeles the equatorial dip in intensity sets in with a good deal of accuracy at a magnetic latitude of  $41^\circ$ , that is, just a few miles south of Pasadena. Similarly, in the Atlantic Ocean the equatorial dip sets in apparently quite sharply very close to  $41^\circ$  or  $42^\circ$  magnetic latitude.

Another result of the sea level surveys is that there seems to be very nearly symmetry between the effects observed in the Northern Hemisphere and in the Southern. The results are not complete enough to make this

symmetry a certainty. This report is rather one of progress, for the sea level investigation is still under way.

A careful study of the longitude effect in the equatorial belt *at high altitudes* is even more important than at sea level for out of it must come pretty definite and conclusive evidence of the existence or non-existence of photonic radiations coming in from outside and producing in part the ionizing effects actually observed in our atmosphere. Dr. Neher and I are therefore now in the process of making in collaboration with Dr. S. A. Korff high altitude flights with accurate recording electroscopes first in Peru and second in the Asiatic area represented by the Philippines, Java and Singapore. We can present as yet only the results obtained in Peru up to 26,100 ft. These show a continuous exponential rise of the ionization with a coefficient 0.5 per meter of water without any tendency as yet to be influenced by the linear rate of increase with altitude which we have estimated should be obtained if there were any large charged-particle component as distinct from photonic component of the radiations in the equatorial belt. Our former conclusion as to this exponential rise in intensity up to and considerably beyond our former measured levels is thus nicely confirmed. Within a month or so we hope to have similar records from the Philippines. If these should show very markedly lower ionization at high altitude on that side of the earth, such as Clay has recently reported in preliminary and admittedly inaccurate work, there will be no possibility in our judgment of explaining this difference on the theory of incoming photons, so that we hope to have very soon a rather definite answer to this important question through our study of the high altitude longitude effect in the equatorial belt.

These two surveys, one at sea level and one at high altitudes, are being supported by grants from the Carnegie Corporation of New York administered by the Carnegie Institution of Washington, to which institutions we desire to express our thanks for this assistance.